Low cost embedded fixture control of LED fixtures

Abstract

A novel scheme to control LED fixtures is proposed harnessing power from output of a constant current LED driver. The Low Voltage Dimming Constant Current (LVDCC) driver module is placed in series between LED driver and LED fixture. It has ability to control light level, color etc using external wireless or wired communication protocols. LVDCC also has ability to convert a single channel output of LED driver to multi-channel color/color temperature control of LED fixture.

Description

Control of lighting fixtures usually require addition of a control module that interfaces with LED fixture using digital or analog communication protocols. Figure 1 illustrates one such example, wherein control module sources power directly from mains and controls LED current using well known protocols like 0-10V or DALI. The control module receives external input using wireless protocols like BLE or Zigbee. External input could also be wired protocols like Ethernet, CAN or other proprietary protocols.

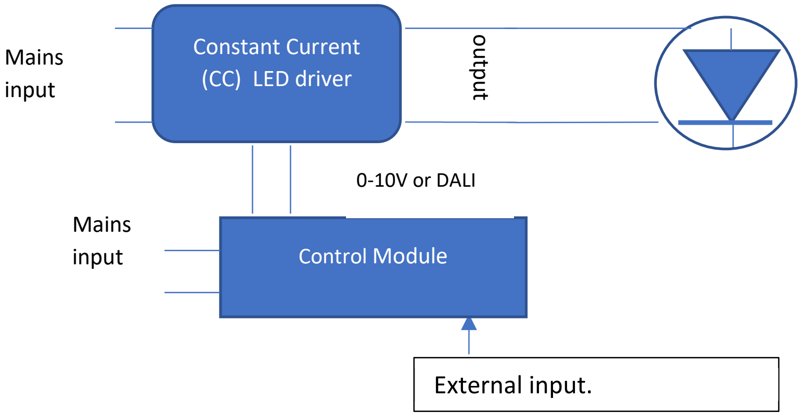

Figure 1. Prior art: LED fixture control using mains powered control module

In another existing art configuration, LVDCC is powered from a Constant Voltage (CV) driver. The technology used in LVDCC is well-known LED driver industry and used in existing art as illustrated in Figure 2.

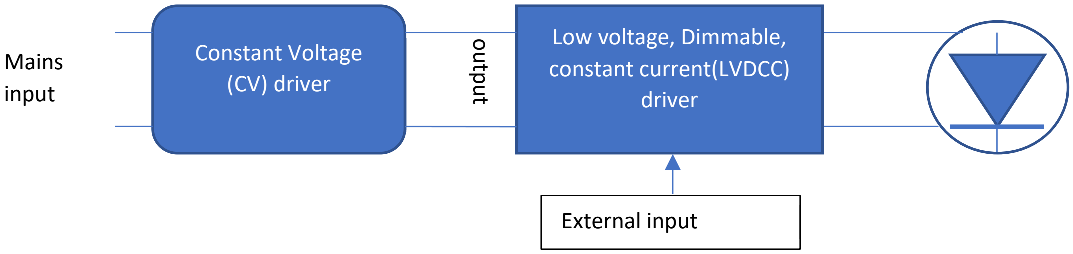

Figure 2: Prior art using Constant Voltage (CV) driver

Figure 2 shows the existing art and it consists of a Constant Voltage (CV) driver and LVDCC driver connected in series. LVDCC receives constant voltage as input and provides dimmable current as output to LED fixture. CV drivers contain technology that is used in common power supplies (an example is an AC/DC flyback converter with isolation) and it provides a constant and regulated voltage. The magnitude of the output voltage can be anything, depending on LED fixture design.

However, these existing solutions require CV driver or a power supply. Typically, CV drivers are more expensive due to reduced market demand.

The proposed solution uses a Constant Current (CC) driver which are manufactured in volume. The proposed solution makes the constant current driver to act like Constant Voltage driver. This is accomplished as follow

1) The "non-dimmable, constant-current" (NDCC) driver is selected such that NDCC open circuit voltage is higher than required LVDCC output voltage. Note that the NDCC driver contains inbuilt constant current regulation which adjusts the output voltage to ensure the flow of constant current, say $I1_{fixed}$. When the current flow is less than $I1_{fixed}$, the NDCC driver will continue to increase the output voltage to force a flow of the current. However, the NDCC driver is also designed to not to exceed class-2 voltage levels, which is usually below 60V. When the NDCC driver is not able to supply, its output voltage will raise to its open circuit max voltage, say$V1_{open}$.
2) LVDCC driver module is programmed to receive the voltage and generate a current to supply to LED light source, say $I2_{dimmable}$ which is programmed to be equal or less than $I1_{fixed}$.
3) LVDCC driver is also designed to monitor and ensure that the output voltage V1 is always higher than the forward voltage of the LEDs.

With the above unique operating conditions, the LVDCC is made to provide a voltage higher than the forward voltage of the LED strings.

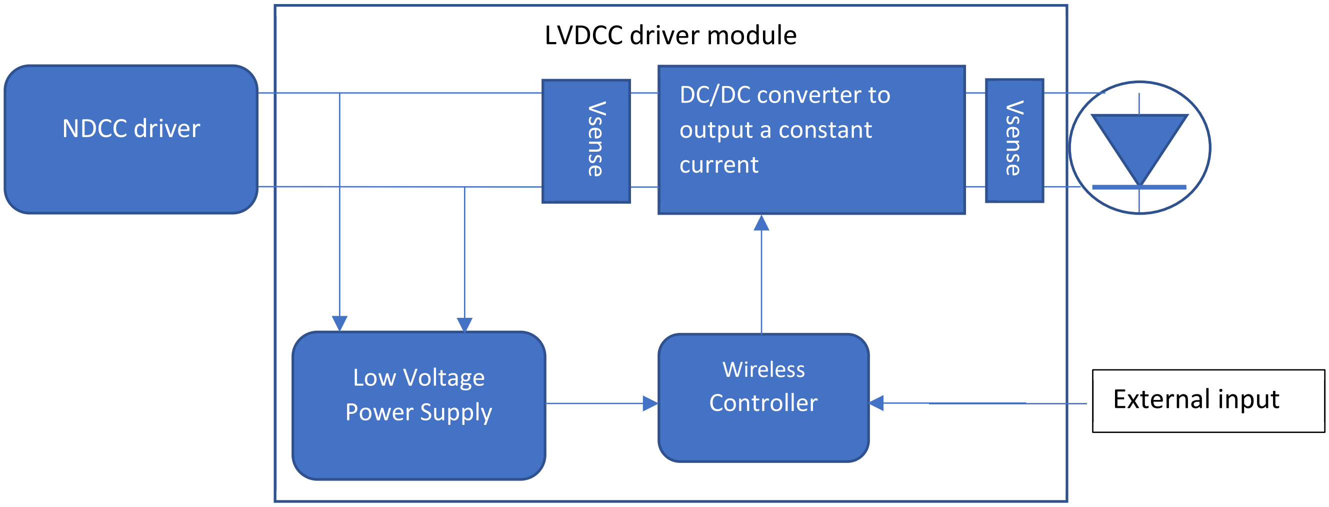

Figure 3: Description of inner working of LVDCC

Figure 3 shows block diagram to describe the functions inside the LVDCC. It contains:

a) Low voltage power supply which generates the voltage required to operate the microprocessor and other electronics inside the parasitic driver.
b) A DC/DC converter which is connected to the output of the constant driver and supplies a constant current to the LED light source. The DC/DC converter receives input that determines the magnitude of the constant current.
c) A voltage sensing circuitry which senses the output and input voltage and provide feedback signals.
d) A controller circuitry contains microprocessor which receives input signals either wireless means or via wired means, the voltage and current feedback and has the algorithms to determine the magnitude of the constant current that must flow through the LED light source and supplies the signals to the DC/DC driver.
e) The microprocessor also contains software algorithms to monitor the feedbacks and ensure that the conditions described above are met and the NDCC always provides a voltage higher than the forward voltage of LED strings.
f) The controller circuitry receives lighting control commands or signals (example include ON/OFF, dimming and color temperature) and control the light source by signaling the DC/DC converter.
g) The controller can also be connected to sensors such a temperature, occupancy and photocells and has the means to receive digital or analog inputs and control the current output.
h) The LVDCC module when designed with wireless capabilities such as BLE, can connect to a mobile which can be used to program the configuration parameters.
i) The LVDCC can be made to perform RGB color or Corelated Color Temperature (CCT) control using multi-channel outputs.